

WHAT IS CLAIMED IS:

1           1.       A computer implemented diagnostic tool for automatically diagnosing a system  
2 by:  
3           determining a path in the storage system to test, wherein the path includes path  
4 components including at least a host adaptor, a link, a device interface, and a device;  
5           performing an initial test to determine if there is a failure in the path;  
6           adding at least one of the path components to a suspect list capable of being a cause of  
7 the failure, wherein the suspect list is implemented in a computer readable data structure;  
8           performing at least one isolation test on at least one of the path components added to  
9 the suspect list;  
10          removing the tested path component from the suspect list if the isolation test confirms  
11 that the tested path component cannot be a source of the failure; and  
12          returning the suspect list to a user to provide information on the path components  
13 capable of being the cause of the failure.

1           2.       The method of claim 1, wherein the initial test comprises a test of the path, and  
2 wherein path components are added to the suspect list and isolation tested after the initial test  
3 indicates a path failure.

1           3.       The method of claim 1, wherein the initial test comprises a test of the path, and  
2 wherein path components are added to the suspect list and isolation tested after the initial test  
3 indicates no path failure to provide additional testing of the path components.

1           4.       The method of claim 1, wherein isolation testing the host adaptor comprises:  
2           generating output to instruct the user to disconnect the host adaptor from the link,  
3 wherein the isolation test is performed on the host adaptor after the user provides input

FOOTNOTES

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1           8.       The method of claim 6, wherein if the device interface isolation test indicates  
2   that the device interface is not one cause of the failure, further performing:  
3       removing the device interface from the suspect list; and  
4       performing a device isolation test of the device.

1           9.       The method of claim 1, wherein performing the isolation testing of the host  
2 adaptor and device interface comprises additional isolation testing of field replaceable units  
3 within the host adaptor and device interface.

1           10.      The method of claim 1, further comprising:  
2           determining whether the path components include at least one switch, device port,  
3 initiator port, and links therebetween, wherein the host adaptor connects through a initial link to  
4 an initiator port on the switch and the device interface connects through a second link to a  
5 device port on the switch; and  
6           performing isolation testing on the switch, device port, initiator port, and the first and  
7 second links if the path includes the switch.

1           11.      The method of claim 1, further comprising:  
2           receiving input from the user indicating a level of testing, wherein the extent of the  
3 isolation tests are determined by the user indicated testing level.

1           12.      The method of claim 1, wherein the device comprises a storage system.

1           13.      The method of claim 12, wherein the storage system comprises storage areas,  
2 further comprising:  
3           receiving input from the user indicating storage areas to test in the storage system,  
4 wherein the isolation tests on the storage system are performed with respect to those storage  
5 areas indicated by the user.

1           14.      The method of claim 12, wherein the storage system adheres to the Fibre  
2 Channel protocol and architecture and the link comprises an optical fiber wire.

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1           15.     The method of claim 1, wherein the system is capable of including different  
2 types of host adaptors and device interfaces, wherein there is a separate isolation test for each  
3 of the different types of host adaptors and device interfaces that are capable of being included  
4 in the system, and wherein performing an isolation test with respect to one host adaptor or  
5 device interface comprises:

6           determining a type of the host adaptor or device interface; and  
7           performing the isolation test for the determined type of host adaptor or device interface.

1           16.     A system for automatically diagnosing a storage system, comprising:

2           (a) a storage system includes a plurality of path components comprising:

3                   (i) a host adaptor;

4                   (ii) a link;

5                   (iii) a device interface; and

6                   (iv) a device; and

7           (b) a processor;

8           (c) a computer readable medium accessible to the processor;

9           (d) a suspect list embedded in the computer readable medium; and

10          (e) a diagnostic software embedded in the computer readable medium capable of  
11 causing the processor to perform:

12                   (i) performing an initial test to determine if there is a failure in the path;

13                   (ii) adding at least one of the path components to the suspect list capable of  
14 being a cause of the failure;

15                   (iii) performing at least one isolation test on at least one of the path components  
16 added to the suspect list;

17                   (iv) removing the tested path component from the suspect list if the isolation test  
18 confirms that the tested path component cannot be a source of the failure; and

19 (v) returning the suspect list to a user to provide information on the path  
20 components capable of being the cause of the failure.

1 17. The system of claim 16, wherein the initial test comprises a test of the path, and  
2 wherein path components are added to the suspect list and isolation tested after the first test  
3 indicates a path failure.

1 18. The system of claim 16, wherein the first test comprises a test of the path, and  
2 wherein path components are added to the suspect list and isolation tested after the first test  
3 indicates no path failure to provide additional testing of the path components.

1 19. The system of claim 16, wherein isolation testing the host adaptor comprises:  
2 generating output to instruct the user to disconnect the host adaptor from the link,  
3 wherein the isolation test is performed on the host adaptor after the user provides input  
4 indicating that the host adaptor was disconnected, wherein the host adaptor is removed from  
5 the suspect list if the host adaptor passes the diagnostic test.

1 20. The system of claim 19, wherein the diagnostic tool software is further capable  
2 of causing the processor to perform:  
3 generating output to instruct the user to replace the link if the host adaptor passes the  
4 test;  
5 performing a link isolation test on the path with the new link; and  
6 removing path components from the suspect list if the link isolation test on the replaced  
7 link indicates that the link was one cause of the failure.

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1           21.     The system of claim 20, wherein if the link isolation test indicates that the link is  
2 not one cause of the failure, then the diagnostic tool software is further capable of causing the  
3 processor to perform:

4           removing the link from the suspect list;  
5           generating output to instruct the user to reinstall the previously replaced link; and  
6           performing a device interface isolation test of the device interface.

1           22.     The system of claim 21, wherein the diagnostic tool software is further capable  
2 of causing the processor to perform

3           generating output to instruct the user to disconnect the device interface from the link to  
4 allow for isolation testing of the device interface.

1           23.     The system of claim 21, wherein if the device interface isolation test indicates  
2 that the device interface is not one cause of the failure, further performing:

3           removing the device interface from the suspect list; and  
4           performing a device isolation test of the device.

1           24.     The system of claim 16, wherein performing the isolation testing of the host  
2 adaptor and device interface comprises additional isolation testing of field replaceable units  
3 within the host adaptor and device interface.

1           25.     The system of claim 16, wherein the diagnostic tool software is further capable  
2 of causing the processor to perform:

3           determining whether the path components include at least one switch, device port,  
4 initiator port, and links therebetween, wherein the host adaptor connects through a first link to

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5 an initiator port on the switch and the device interface connects through a second link to a  
6 device port on the switch; and  
7 performing isolation testing on the switch, device port, initiator port, and the first and  
8 second links if the path includes the switch.

1 26. The system of claim 16, wherein the diagnostic tool software is further capable  
2 of causing the processor to perform:  
3 receiving input from the user indicating a level of testing, wherein the extent of the  
4 isolation tests are determined by the user indicated testing level.

1 27. The system of claim 16, wherein the device comprises a storage system.

1 28. The system of claim 27, wherein the storage system comprises storage areas,  
2 wherein the diagnostic tool software is further capable of causing the processor to perform:  
3 receiving input from the user indicating storage areas to test in the storage system,  
4 wherein the isolation tests on the storage system are performed with respect to those storage  
5 areas indicated by the user.

1 29. The system of claim 27, wherein the storage system adheres to the Fibre  
2 Channel protocol and architecture and the link comprises an optical fiber wire.

1 30. The system of claim 16, wherein the system is capable of including different  
2 types of host adaptors and device interfaces, wherein there is a separate isolation test for each  
3 of the different types of host adaptors and device interfaces that are capable of being included  
4 in the system, and wherein performing an isolation test with respect to one host adaptor or  
5 device interface comprises:

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- 6 determining a type of the host adaptor or device interface; and  
7 performing the isolation test for the determined type of host adaptor or device interface.

- 1 31. An article of manufacture for implementing a diagnostic tool for automatically  
2 diagnosing a system, wherein the diagnostic tool is embedded in a computer readable medium  
3 and includes code capable of causing a processor to perform:  
4 determining a path in the storage system to test, wherein the path includes path  
5 components including at least a host adaptor, a link, a device interface, and a device;  
6 performing an initial test to determine if there is a failure in the path;  
7 adding at least one of the path components to a suspect list capable of being a cause of  
8 the failure, wherein the suspect list is implemented in a computer readable data structure;  
9 performing at least one isolation test on at least one of the path components added to  
10 the suspect list;  
11 removing the tested path component from the suspect list if the isolation test confirms  
12 that the tested path component cannot be a source of the failure; and  
13 returning the suspect list to a user to provide information on the path components  
14 capable of being the cause of the failure.

- 1 32. The article of manufacture of claim 31, wherein the initial test comprises a test  
2 of the path, and wherein path components are added to the suspect list and isolation tested after  
3 the initial test indicates a path failure.

- 1 33. The article of manufacture of claim 31, wherein the initial test comprises a test  
2 of the path, and wherein path components are added to the suspect list and isolation tested after  
3 the initial test indicates no path failure to provide additional testing of the path components.

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1           34.     The article of manufacture of claim 31, wherein isolation testing the host  
2 adaptor comprises:  
3           generating output to instruct the user to disconnect the host adaptor from the link,  
4 wherein the isolation test is performed on the host adaptor after the user provides input  
5 indicating that the host adaptor was disconnected, and wherein the host adaptor is removed  
6 from the suspect list if the host adaptor passes the diagnostic test.

1           35.     The article of manufacture of claim 34, wherein the diagnostic tool code is  
2 further capable of causing the processor to perform:  
3           generating output to instruct the user to replace the link if the host adaptor passes the  
4 test;  
5           performing a link isolation test on the path with the new link; and  
6           removing path components from the suspect list if the link isolation test on the replaced  
7 link indicates that the link was one cause of the failure.

1           36.     The article of manufacture of claim 34, wherein if the link isolation test indicates  
2 that the link is not one cause of the failure, and wherein the diagnostic tool code is further  
3 capable of causing the processor to perform:  
4           removing the link from the suspect list;  
5           generating output to instruct the user to reinstall the previously replaced link; and  
6           performing a device interface isolation test of the device interface.

1           37.     The article of manufacture of claim 36, wherein the diagnostic tool code is  
2 further capable of causing the processor to perform:  
3           generating output to instruct the user to disconnect the device interface from the link to  
4 allow for isolation testing of the device interface.

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1           38.     The article of manufacture of claim 36, wherein if the device interface isolation  
2 test indicates that the device interface is not one cause of the failure, further performing:  
3           removing the device interface from the suspect list; and  
4           performing a device isolation test of the device.

1           39.     The article of manufacture of claim 31, wherein performing the isolation testing  
2 of the host adaptor and device interface comprises additional isolation testing of field  
3 replaceable units within the host adaptor and device interface.

1           40.     The article of manufacture of claim 31, wherein the diagnostic tool code is  
2 further capable of causing the processor to perform:  
3           determining whether the path components include at least one switch, device port,  
4 initiator port, and links therebetween, wherein the host adaptor connects through a initial link to  
5 an initiator port on the switch and the device interface connects through a second link to a  
6 device port on the switch; and  
7           performing isolation testing on the switch, device port, initiator port, and the first and  
8 second links if the path includes the switch.

1           41.     The article of manufacture of claim 31, wherein the diagnostic tool code is  
2 further capable of causing the processor to perform:  
3           receiving input from the user indicating a level of testing, wherein the extent of the  
4 isolation tests are determined by the user indicated testing level.

1           42.     The article of manufacture of claim 31, wherein the device comprises a storage  
2 system.

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1           43.     The article of manufacture of claim 42, wherein the storage system comprises  
2     storage areas, wherein the diagnostic tool code is further capable of causing the processor to  
3     perform:

4           receiving input from the user indicating storage areas to test in the storage system,  
5     wherein the isolation tests on the storage system are performed with respect to those storage  
6     areas indicated by the user.

1           44.     The method of claim 1, wherein the system is capable of including different  
2     types of host adaptors and device interfaces, wherein there is a separate isolation test for each  
3     of the different types of host adaptors and device interfaces that are capable of being included  
4     in the system, and wherein performing an isolation test with respect to one host adaptor or  
5     device interface comprises:

6           determining a type of the host adaptor or device interface; and  
7           performing the isolation test for the determined type of host adaptor or device interface.

1           45.     A computer readable medium including data structures used to perform  
2     diagnostic testing of a system, comprising:

3           a rule object including code defining a flow of operations to perform diagnostic testing  
4     of a path in the system, wherein the path includes path components including at least a host  
5     adaptor, a link, a device interface, and a device, wherein the rule object calls test descriptors  
6     associated with a testing operation to perform;

7           a test descriptor object including test descriptors, wherein each test descriptor specifies  
8     one or more program modules to perform the testing operation associated with the test  
9     descriptor; and

10          a module object including program modules providing code to perform testing  
11     operations, wherein a call to one test descriptor executes the program modules specified by the

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12 test descriptor to perform diagnostic testing operations according to the operation flow  
13 specified in the rule object.

1 46. The computer readable medium of claim 45, wherein multiple program modules  
2 call at least one library module to perform diagnostic related operations performed within the  
3 multiple program modules.

1 47. The computer readable medium of claim 46, further comprising a suspect list  
2 data structure indicating path components capable of being a source of a failure in the tested  
3 path, wherein the rule object includes code to add path components capable of being a source  
4 of the failure to the suspect list and removes path components from the suspect list that are  
5 determined not to be capable of being the source of the failure..

1 48. The computer readable medium of claim 46, wherein the flow of operations  
2 defined in the rule object comprises:  
3 calling a first test descriptor, wherein the first test descriptor specifies at least one  
4 program module to determine if there is a failure in the path;  
5 adding at least one of the path components to the suspect list that is capable of being a  
6 cause of the failure;  
7 calling at least one isolation test descriptor associated with at least one of the path  
8 components added to the suspect list, wherein the isolation test descriptor specifies at least one  
9 program module to determine if there is a failure in the path component associated with the  
10 called isolation test descriptor;  
11 removing the path component from the suspect list if the isolation test defined by the  
12 called isolation test descriptor confirms that the tested path component cannot be a source of  
13 the failure; and

- 14            returning the suspect list to a user to provide information on possible failed components
- 15    in the tested path.

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